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REPORT ON COLUMBIA RIVER POWER PROJECT NEAR THE DALLES, OREGON.

BY L. F. HARZA

LOYALTY OF CORPORATION EMPLOYES

BY R. H. BALLARD

EFFICIENCY OF ILLUMINATION.

BY RICHARD E. SMITH

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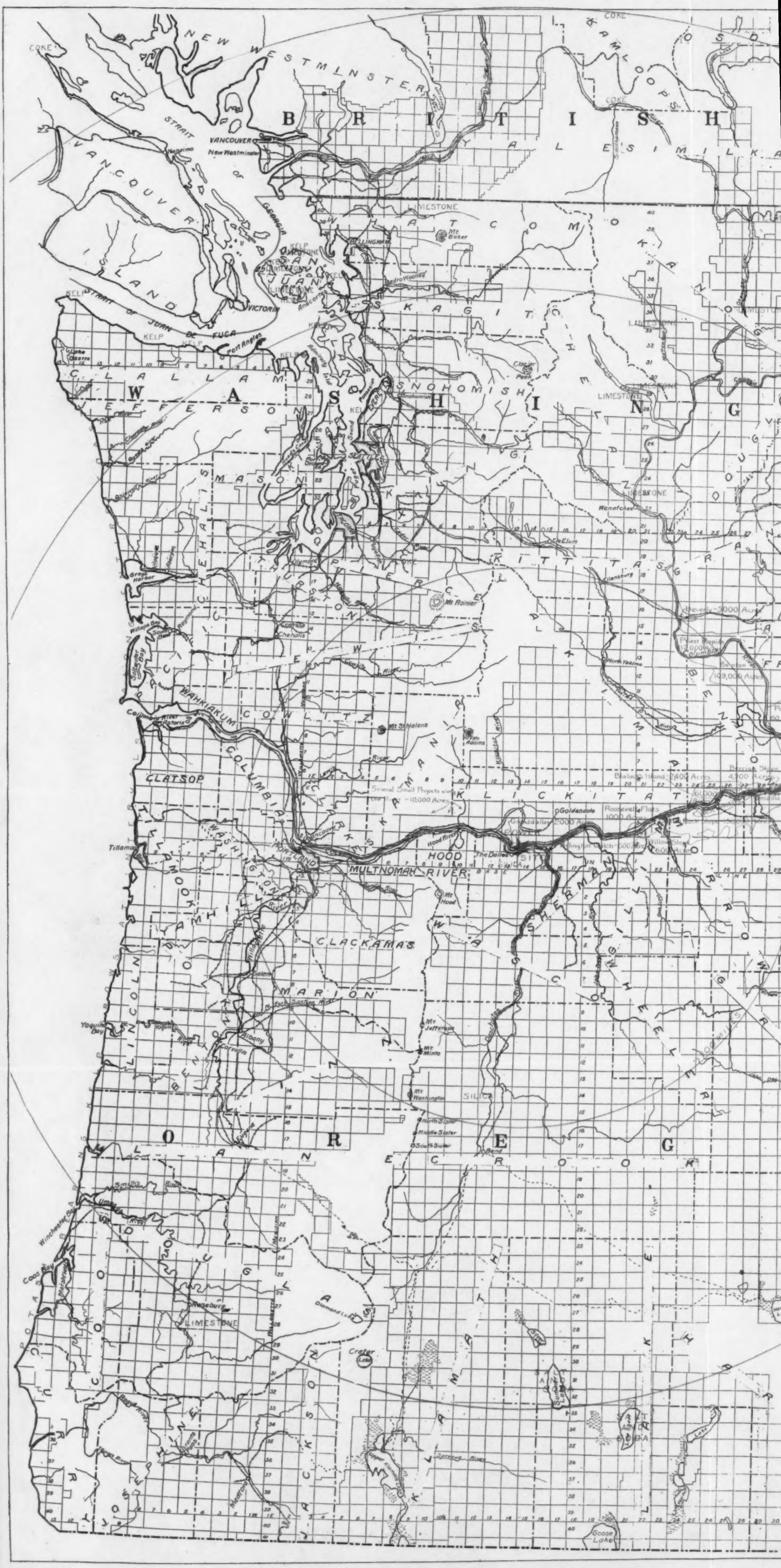
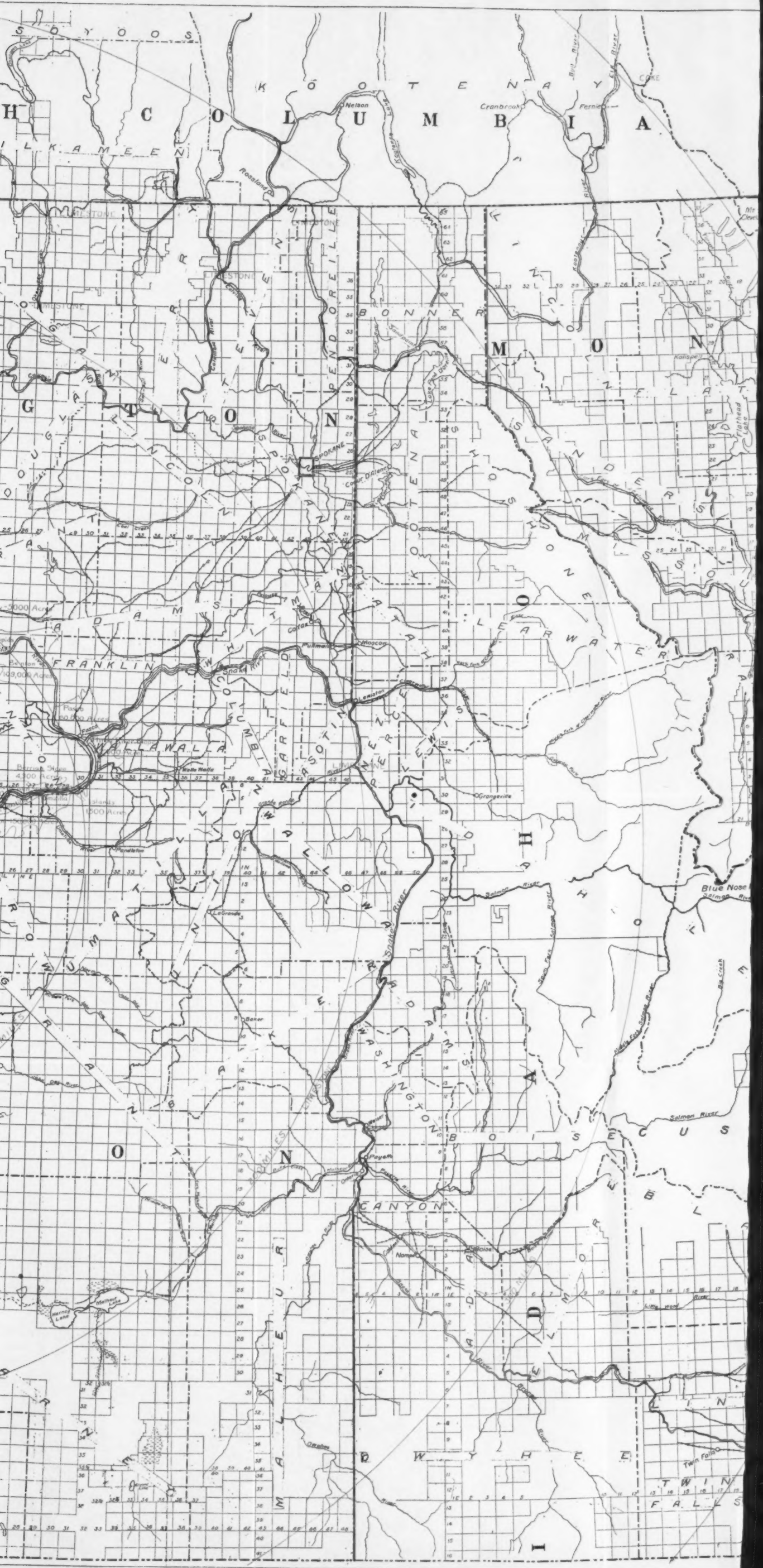


FOLDING PLATE NO. 1. GENERAL MAP OF COLUMBIA RIVER POWER PROJECT.


S O O S
K O O T E N A Y
H C O L U M B I A
Nelson
Cranbrook
Fernie
Rossland
Trail
Grand Forks
Kettle River
Boundary
Columbia River
Arrow Lakes
Slocan
Kaslo
Revelstoke
Golden
Mt. Cleveland
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Cranbrook
Fernie
Mt. Cleveland
Kootenay River
Bull River
Elk River
Coke
Kootenai River
Kootenai Lake
Kootenai Falls
Libby
Troy
Yaak River
Yaak Falls
Yaak Falls Dam
Lake Pend Oreille
Pend Oreille River
Priest River
Priest Lake
Priest River Dam
Sandpoint
Bonner
Boundary
Kalispell
Flathead Lake
Flathead River
Flathead Indian Reservation
Missoula
Missoula Valley
Missoula Gravels
Clearwater River
Clearwater Mts.
Clearwater Range
Lochsa River
Selway River
Selway Forest
Selway-Bitterroot Primitive Area
Bitterroot Range
Bitterroot Valley
Bitterroot River
Big Hole River
Big Hole Basin
Big Hole Mts.
Big Hole Range
Big Hole Valley
Anaconda
Mt. Higgin
Deer Lodge
Deer Lodge Valley
Blue Nose Mt.
Monument Mt.
Salmon River
Salmon River Mts.
Salmon River Range
Pahsimeroi River
Lemhi River
Lemhi Range
Lemhi Valley
Lemhi Pass
Beaverhead Range
Beaverhead Mts.
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Centennial Valley
Continental Divide
Red Rock Lakes
Red Rock River
Red Rock Pass
Henrys Lake
Henrys Fork
Snake River
Snake River Plain
Spokane
Coeur d'Alene
Coeur d'Alene Lake
Coeur d'Alene River
St. Joe River
St. Joe Mts.
St. Joe National Forest
Cataldo
Mission
Cottonwood
Moscow
Pullman
Lewiston
Grangeville
Craig Mt.
Craig Mt. Wildlife Range
Camas Prairie
Salmon River Breaks
Salmon River Breaks Primitive Area
Weiser
Payette
Payette River
Boise
Boise River
Boise Basin
Boise Mts.
Boise Range
Sawtooth Range
Sawtooth National Forest
Sawtooth Primitive Area
Sawtooth Wilderness Area
Stanley Basin
Stanley
Challis
Challis Volcanics
Challis Creek
Big Creek
Big Creek Primitive Area
Middle Fork Salmon River
Middle Fork Primitive Area
Middle Fork Wilderness Area
Middle Fork of Clearwater River
Lochsa Primitive Area
Lochsa Wilderness Area
Lochsa Falls
Lolo Creek
Lolo Pass
Lolo Trail
Lolo Hot Springs
Bitterroot Mts.
Bitterroot National Forest
Bitterroot Primitive Area
Bitterroot Wilderness Area
Selway Primitive Area
Selway Wilderness Area
Selway Falls
Selway Forest
Selway-Bitterroot Primitive Area
Selway-Bitterroot Wilderness Area
Selway Falls
Lochsa River
Lochsa Falls
Lochsa Primitive Area
Lochsa Wilderness Area

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Butte
Anaconda
Deer Lodge
Hamilton
Missoula
Kalispell
Whitefish
Libby
Thompson Falls
Plains
Polson
Ronan
Lewistown
Harlowton
Roundup
Miles City
Forsyth
Hardin
Billings
Red Lodge
Big Timber
Columbus
Virginia City
Ennis
Three Forks
Manhattan
Belgrade
Townsend
Boulder
Whitehall
Ekalaka
Baker
Broadus
Sidney
Glendive
Wibaux
Terry
Ismay
Jordan
Circle
Glasgow
Malta
Havre
Chinook
Harlem
Fort Benton
Choteau
Conrad
Shelby
Cut Bank
Browning
Valier
Kevin
Sunburst
Big Sandy
Box Elder
Rocky Boy
Hingham
Chester
Joplin
Inverness
Dodson
Saco
Scobey
Opheim
Flaxville
Plentywood
Westby
Culbertson
Wolf Point
Poplar
Brockton
Fort Peck
Nashua
Glasgow
Malta
Havre
Chinook
Harlem
Fort Benton
Choteau
Conrad
Shelby
Cut Bank
Browning
Valier
Kevin
Sunburst
Big Sandy
Box Elder
Rocky Boy
Hingham
Chester
Joplin
Inverness
Dodson
Saco
Scobey
Opheim
Flaxville
Plentywood
Westby
Culbertson
Wolf Point
Poplar
Brockton
Fort Peck
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Plate II. View of Five Mile Rapids, looking down stream from the Oregon Shore at the Damsite.

REPORT ON COLUMBIA RIVER POWER PROJECT

NEAR THE DALLES, OREGON

BY L. F. HARZA

(For the first time are here presented the results of the investigation of the power development of the Columbia River at The Dalles, Oregon, by the State of Oregon and the U. S. Reclamation Service. This exhaustive report includes not only a study of the power development but also of the possible market and will be published in its entirety as a series of continued articles.—The Editor.)

Introduction.

Attention was directed to the possibilities of developing large water powers on the Columbia River near The Dalles, Oregon, by a supplement to the Fourth Biennial Report of John H. Lewis, State Engineer of Oregon, entitled "The Columbia Power Project," being Bulletin No. 3, dated January 11, 1913. This report, addressed to Hon. Oswald West, Governor of Oregon, recommended that money be appropriated by the legislature for the thorough investigation of one or more specific projects, to the end that a comprehensive water power policy might be framed.

The legislature of the state of Oregon, by act of March 4, 1913 (Chapter 374 of the General Laws of Oregon for 1913), appropriated the sum of fifteen thousand dollars ($15,000) for this purpose. This fund was placed in the hands of an investigating committee, comprising, as finally constituted: I. N. Day and J. C. Smith of the Senate, J. D. Abbott and Vernon A. Forbes of the House and John H. Lewis, State Engineer.

By provision of the above act this committee was given authority to enter into contract with the state of Washington or the Federal government or both, for joint conduct of the investigation. Subsequently, upon the invitation of the committee, the Secretary of the Interior allotted from the Reclamation Fund an equal amount, or fifteen thousand dollars, for the investigation, under a co-operative agreement, which was duly executed under date of December 12, 1913, between E. G. Hopson, Supervising Engineer, U. S. Reclamation Service, acting for the United States, and I. N. Day, J. D. Abbott and John H. Lewis, authorized by the committee to act for the state of Oregon.

This agreement provided for equal expenditures by the two parties, and also that surveys and investigations be made leading to the preparation of detailed plans, specifications and estimates of cost for the maximum economical development of this water power, and that following the completion of the above, conclusions and recommendations be made in the matter of utilizing, reserving or disposing of public waters, lands and other natural resources to the highest public advantage, including the correlation of the use of water for irrigation pumping, navigation and other uses. The agreement also defined the manner in which the work should be organized and carried out.

Pursuant to the above agreement, E. G. Hopson, Supervising Engineer, U. S. Reclamation Service, was appointed by the Secretary of the Interior on January 14, 1914, to supervise operations and in addition to serve with O. H. Ensign, Chief Electrical Engineer, U. S. Reclamation Service, as consulting engineer on the work. On February 2, 1914, an understanding was reached by the members of the state legislative committee and the supervising engineer as to the general plan of operations, and L. F. Harza, a consulting engi-

neer, of Portland, Oregon, was appointed to serve as project engineer during the course of the investigation. A project office was established at The Dalles, Oregon, and a corps of engineers, drillman and laborers was organized at that place, work being commenced about February 15th. The project engineer has personally conducted all engineering field and office work.

All studies and conclusions herein detailed, except as specified below, were compiled and written by L. F. Harza in conference with E. G. Hopson, the work being reviewed by O. H. Ensign.

Investigations have been made of a number of special topics related or subordinate to the general investigation of Columbia River power dealt with herein. These have been handled by independent specialists in their respective fields, and their reports appear herein under the names of the contributors as follows:

Electro Metallurgical Industries:
Dorsey A. Lyon, Metallurgist U. S. Bureau of Mines.
Robert M. Keeney, Metallurgical Engineer, formerly with U. S. Bureau of Mines.

Electro-Chemical Industries:
O. F. Stafford, Professor of Chemistry, University of Oregon, assisted by contributors on special subjects as follows:
Fertilizer Industry—Frank K. Cameron, Chief Chemist, Bureau of Soils, U. S. Department of Agriculture.
Utilization of Western Phosphates—W. H. Waggaman, Bureau of Soils, U. S. Department of Agriculture.
Utilization of Potash Bearing Minerals—W. H. Ross, U. S. Department of Agriculture.

Hydrography:
Fred F. Henshaw, District Engineer, U. S. Geological Survey.

Meteorological Conditions:
Edward A Beals, District Forecaster, U. S. Weather Bureau.

Irrigation Pumping:
Joseph Jacobs, Consulting Engineer U. S. Reclamation Service.

Navigability of Columbia and Snake Rivers:
Major Jay J. Morrow, Corps of Engineers, U. S. A.

The hydraulic conditions of the site which controlled the design of the project were revealed chiefly by data collected during a period of many years by the Corps of Engineers, U. S. A., in connection with the design of The Dalles-Celilo Navigation Canal, and without which data not even approximate designs would have been possible. Appreciation is due to Major J. J. Morrow, Capt. T. H. Dillon, Mr. F. C. Schubert and others of the Engineer Corps, who very kindly assisted in an advisory way in the furnishing and interpretation of hydrographic data and cost records of the work carried on under their direction.

Special thanks are also due to Prof. Milton Whitney, Chief of the Bureau of Soils, and Mr. J. A. Holmes, Director U. S. Bureau of Mines, who authorized the donation of services and expenses of some of the above contributors, and have otherwise cooperated in a very helpful manner.

Among the principal assistants of the engineer corps were O. G. Aichel and L. H. Huntley, designing engineers; L. T. Boyle, chief of survey parties; F. I. Roth, Frank Sperb and Erwin Dames, designers and draftsmen. The core borings were carried out chiefly by Mr. James Dopson.

General Summary Report on Columbia River Power Project Near The Dalles, Oregon.

This general report is submitted as a summary of the data compiled and conclusions reached in the more technical attached appendices in regard to the feasibility of an hydroelectric development at "Five Mile Rapids" of the Columbia River near The Dalles, Oregon, the maximum amount of power which can be economically developed at that place, the most feasible general scheme of development, the types and general design of structures best suited for the conditions encountered, the cost of the proposed development, the annual cost of generating and delivering power, and the possibilities of utilizing this power for agriculture, the arts and for commerce.

Status of the investigation: It is obvious that the investigation of a project so great and far-reaching in its complications and possibilities of use as this, could not be perfected in the few months available for the work. The natural and almost necessary sequence of operations required that field surveys be first completed or nearly so, before the study of property damage from backwater influence could be made and hence before the feasible level of head-water control as thus determined (or influenced) could be decided upon; this decision was necessary before much headway could be made in the design of controlling works, canal and power house, selection of machinery and estimates of cost; the compilation of discharge data and deduction of numerous facts therefrom greatly influencing the design of the proposed works, was also required before more than tentative studies of design could be prosecuted; the dimensions and even the types of certain portions of the controlling works were dependent upon the ultimate solution of other problems, as, for example, the method of closure of the present channel, which problems required much time and study for their solution; the determination of the controlling conditions as to maximum head, range of heads and power, was necessary before the machinery manufacturers could prepare their estimates of cost and furnish controlling dimensions of the mechanical equipment; these dimensions were necessary before more than a rough layout and estimate of the power house was possible; the entirely unprecedented nature and magnitude of the undertaking required the solution of many novel problems requiring much more than a design of a project coming within the scope of past personal and recorded experience; the specialists engaged in the study of the market for power required the ultimate conclusions of our investigation as to the practicable selling price for power before they could reach more than tentative conclusions as to the possible market.

Time was not available, however, for the conduct of the work in the natural order of sequence above outlined and it was necessary under the circumstances to make such assumptions as to the controlled headwater elevation, magnitude of flood to be passed, type of river closure and similar matters, as seemed at the time most probable of adoption, in order that all work might progress simultaneously.

As would be expected in such procedure, these assumed conditions have not proven the same in all cases as those since agreed upon or found to obtain,

Five Mile Rapids, looking up-stream from Big Eddy on Washington Side at a Flow of about 433,000 second feet.

and it has been impossible for lack of time or funds to revise the study on the basis of corrected assumptions. It so happens, however, that the conditions assumed were in general more severe than necessary; the controlling works although necessarily unprecedented in size, have been designed even larger than would be required in the light of present information. It is fortunate that any error of this kind should be on the side of safety.

The various subjects will be presented in the manner in which they have been analyzed and features in which reductions are justified because of extreme assumptions will be indicated and their effect on cost considered in its proper place by such approximate methods as are available without redesign.

Location and accessibility: The proposed project is located in the northwestern portion of the United States on the Columbia River, the boundary between the states of Oregon and Washington, about ninety miles east of the city of Portland, Oregon, and one hundred and eighty-seven miles above the mouth of the river. (See general map, folding plate No. 1).

The Columbia River is now navigable with ease, for deep draft ocean vessels to the mouth of the Willamette River, ninety-eight miles above the mouth, and for the remaining eighty-nine miles is navigable at all except extreme high water stages and for a few days occasionally during the ice season, for vessels of eight foot draft, the power site being at the present head of navigation. The Dalles-Celilo canal, which is nearing completion, will open the river to transportation up as far as Priest Rapids on the Columbia, about sixty miles above Pasco, and during favorable seasons to Lewiston, Idaho, or even above, on the Snake River.

In addition to the accessibility of this location by water, it should be said that the Columbia River is the only break in the Cascade Mountains (or their continuation, the Sierra Nevadas) within the boundary of the United States. Two transcontinental railroads, the Spokane, Portland and Seattle (Hill system) on the north side, and the Oregon-Washington Railroad & Navigation Company (Harriman system) on the south side, follow the banks of the Columbia River from Pasco to Portland, the former also to Astoria at the mouth of the river. Both of these railroads are immediately adjacent to the power site on either side of the river and furnish the only possible water-grade railroad routes between the sea and the interior. With respect to accessibility for either construction purposes or for transportation of manufactured products, the proposed location is therefore very fortunate.

Description of powersite: An outline map of the Columbia River from The Dalles, Oregon, upward to the limit of important backwater influence is shown in Fig. 1 (see p. 376). The proposed point of diversion is on the Washington side of the river, at the head of what is known as Five Mile Rapids, and about five miles east of the city of The Dalles. The river at this point suddenly contracts from a width at low water of about sixteen hundred feet to a width of about one hundred and fifty feet, and remains nearly this narrow between two high, and nearly vertical canyon walls throughout the length of Five Mile Rapids or to Big Eddy, about one and one-half miles below. Plate II is a view of these rapids from the upper end and from the Oregon side, showing to the right the wide portion of the river above the rapids. Through these rapids the water is of great depth and very turbulent, the fall at low water being about 11 feet and at flood stage about 35 feet. This narrow channel has been cut by the erosive action of the river into the center of a bench, about 2000 ft. wide, of solid black basaltic lava forming the river valley and from which the bluffs of the same material rise abruptly on either side. This

bench, which is very rough, as shown in Plate II, is in general about 50 to 60 ft. above the low water level in the deep channel. It is largely overflowed in extreme floods and annually in low places, especially in the frequent overflow or by-pass channels which have been cut into the bench at higher elevation than the main channel and on either side.

At the beginning of the rapids the water has an approximate depth of 100 ft. at low stage and a short distance below a depth of about 140 ft. The extreme range in elevation at that place is about 93 ft. At the lower end of the rapids the river emerges from the narrow channel into a large pool about 1500 ft. in diameter and with a general depth of about 150 or 200 ft., known as "Big Eddy," from which it follows a tortuous route through a rock canyon less restricted than the former one, for about one mile further to Three Mile Rapids, and thence in a broad deep channel to The Dalles. The maximum range in elevation of Big Eddy is about 70 ft.

Geology: A study of the geological structure of the powersite has shown that the elevated bench through which the narrow channel has been cut was formed by a fault extending nearly at right angles across the river at the upper end of the rapids, and the upheaval of the lava strata on the downstream side of this fault into an inclined position, sloping downstream. Fig. 2 is a typical profile of a river which has been changed in this manner by faulting. This fault block has since eroded down to form the present bench; and later the main thread of the stream where the velocity was the greatest, has worn down so rapidly as to have stolen the entire stream from the main bench and concentrated it into the present canyon, except during high stages.

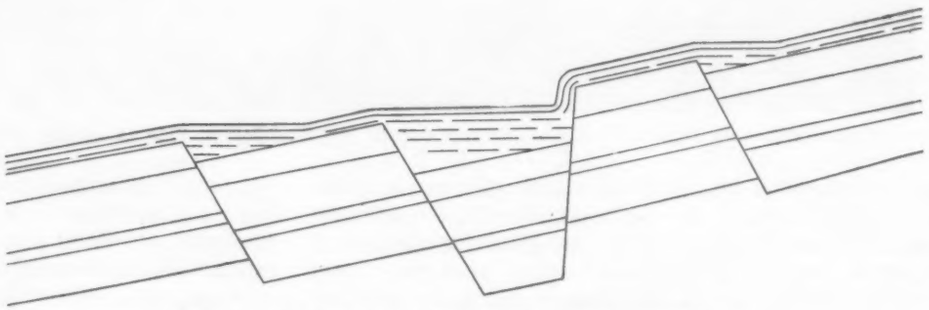


Fig. 2. Ideal Sketch of Faulting along Columbia River.

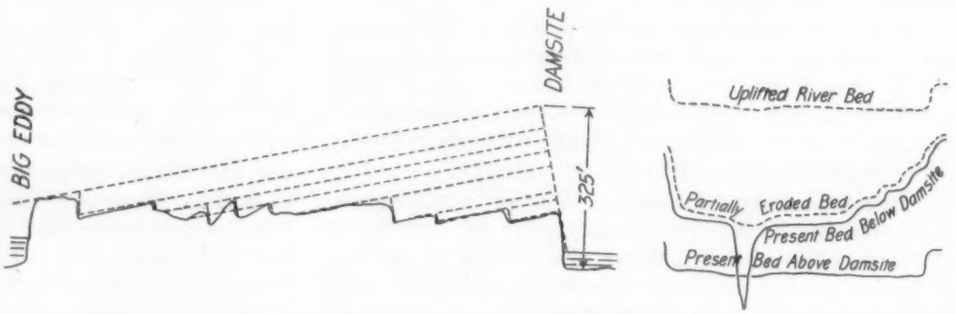


Fig. 3. Geological Structure of Power Site.

Fig. 3 is a geological section along the bench on the Washington side of the river, showing the original lava strata restored, by dotted lines, to their position immediately after the uplift and also the profile as it now is. The total displacement was about 325 feet and a natural dam of this height was apparently formed at that time unless the slip occurred in many small movements separated by long periods of time, with the more or less complete removal of the added obstruction by erosion during the intervals. This subject is more fully discussed in Appendix "A."

Controlling conditions: The power exerted by a river at any place is proportional to the product of its discharge and head or fall. The head which can be utilized is often increased by a dam to much more than the natural fall at the power site. It is governed to some extent by the permissible property damage from lands overflowed as the result of the dam; by the natural fluctuations of the tailwater; by the practicable limit in height and length of dam; by considerations purely of an economic nature.

The flow of a stream is governed by climatic conditions familiar to all. This flow is continually varying and with it usually goes a variation in the available head. The simultaneous values of the two must be considered, especially in low head plants where the variation is often a very large proportion of the total head.

Discharge characteristics: The following table furnishes an interesting comparison of the drainage areas, and the maximum and minimum discharges of several important rivers.*

*With some corrections from Water Supply and Irrigation Paper No. 345-F, U. S. Geological Survey.

Discharge of Some Large Rivers in the United States and of the Yukon and the Nile.

River.	Point.	Drainage Area sq. Miles.	Discharge in sec. ft. Maximum.	Minimum.
Mississippi,	mouth	1,238,000	1,800,000	125,000
Mississippi,	Grafton, Ill.	171,500	360,000	25,000
Ohio,	Paducah, Ky.	202,000	1,400,000	21,000
Missouri,	St. Charles, Mo.	527,000	600,000	5,000
Susquehanna,	McCall Ferry, Pa.	26,800	353,000	2,200
Rio Grande,	Brownsville, Tex.	248,000	35,600	650
Colorado,	Yuma, Ariz.	225,000	150,000	2,700
Yukon,	Eagle, Alaska	122,000	254,000	10,100
St. Lawrence,	Ogdensburg, N. Y.	383,300	330,000	185,000
Nile,	Assouan, Egypt	1,262,000	353,000	14,500
Columbia,	The Dalles, Ore.	237,000	1,170,000	41,900

It will be noted that but two of the rivers listed, the Mississippi at its mouth and the St. Lawrence

River at Ogdensburg, are credited with a minimum discharge greater than the Columbia River. Several others with drainage areas greater or nearly equal to the Columbia, have very small minimum discharges. The relatively high minimum discharge is of correspondingly great advantage in its influence upon the amount of power which can be developed. Only two rivers, the Mississippi and the Ohio, have maximum discharges even comparable with the Columbia, and they are both greater, the latter only slightly. This high flood discharge is a disadvantage to the development of power as it necessitates very expensive dams and controlling works.

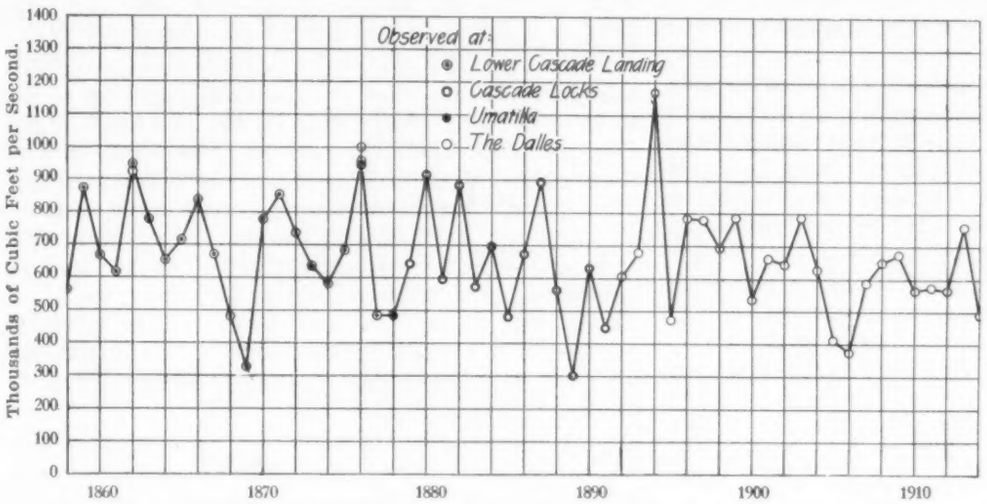


Fig. 4. Magnitude of Annual Flood Peaks at The Dalles from 1858 to 1914.

Although the Columbia River is subject to this wide range of discharge, the flow is nevertheless relatively dependable in that the annual program of variation is unusually regular as compared with most rivers in the eastern part of the United States. This regularity is due to the diversified character of the climatic conditions over its immense drainage area. Owing to the presence of intersecting mountain ranges throughout its area, climatic changes seldom affect the entire area at one time and the flow of the river thus represents an average condition in which a sudden out-of-season freshet or drought on one tributary becomes obscured when averaged with the simultaneous condition of the other tributaries. This uniformity also largely results from the fact that much of the drainage originates in the snow fields of high mountain ranges where the spring thaw is gradual, and, once over for the season, freshets cannot occur until the following spring, as the summer climate is essentially arid even in the mountains. Daily discharge measurements are available for 36 years, as discussed in detail in Appendix "B," which have served to establish in a very satisfactory manner the flow characteristics.

Minimum flow: The usual minimum flow of a river is a more significant quantity in planning a power development than the absolute minimum. The latter in fact can never be determined, and nearly all hydroelectric developments are subject to occasional deficiencies at times of extreme minimum. This is not necessarily an accident when it occurs, but is usually foreseen and planned for. An occasional sacrifice for a few days or even weeks once in several years is preferable from an economic standpoint to the failure to use the power during the major portion of the time when it is available. The extent of the application of this principle necessarily depends upon the character of the load to be served.

Although the minimum flow as shown in the previous table is 41,900 second feet, yet this has occurred but once. It is shown in Appendix "E" that the discharge has fallen below 50,000 second feet only three times in 36 years for periods of one, twelve and thirteen days per annum during 1888, 1890 and 1884 respectively. For the past 20 years it has not fallen below 52,000 second feet.

In view of these facts a flow of 50,000 second feet has been adopted as a conservative minimum upon which to base the power capacity of the proposed station. Prospective diversions for irrigation will not adversely affect this discharge as there is always a surplus of water during the irrigation season.

Flood discharge: Flood controlling works must be designed to pass the maximum flood which is likely to occur. The record of annual floods shown in Fig. 4 indicates that the year 1894 experienced the greatest flood, 1,170,000 second feet, during existing records which extend over a period of 57 years. Based upon this record one might assume the probability that this flood would recur at intervals of about 60 years and that to be safe a greater flood should be used in the design of controlling works. This was actually done and a flood of 1,400,000 second feet, or 20 per cent greater, was used in the design to allow for the above, as well as other reasons discussed more in detail in the appendix. Later in the work the study of annual floods based upon the theory of probabilities, as discussed in Appendix "B," showed that the probable frequency of the 1894 flood is only once in 1000 years. This deduction should be interpreted to mean merely that its actual occurrence once in a record of 57 years is abnormal and need not be anticipated in the future; in fact that its future occurrence is only a very remote possibility. This same study indicated that a flood of 950,000 second feet could be expected once in 25 years, and a flood of 800,000 second feet once in 5 years. In view of this information a smaller flood might well have been assumed for the design of structures, but time for re-design was not available.

During high water the available head of this, as well as of most hydroelectric stations, would decrease, and it would become increasingly expensive, due to the necessity of additional generating machinery, with increasing flood to maintain full station capacity. For this reason there is some flood of a magnitude less than maximum, above which one might preferably sacrifice in station capacity or shut down entirely than to incur the additional expense for these very rare occasions. This limiting flood was selected, as dis-

cussed in Appendix "D," to be 800,000 second feet, which was shown in Appendix "B" to have a probable frequency of once in 5 years. As the discharge would increase above this magnitude the headwater would be lowered with reference to property damage above until, at a flood of 950,000 second feet occurring with a probable frequency of 25 years the natural level of the river for this discharge would have been reached. It should be observed from Fig. 4 that no flood has equalled or exceeded 800,000 second feet during the last 20 years and a much less erratic flood discharge is very evident during this period than during the earlier years of the record.

Available head: The two railroads on either side of the river are the chief property interests influencing the choice of working head. An elaborate study of the backwater curves for dams of several assumed heights and other data discussed in Appendix "D" has shown that the water could be controlled to an elevation of 151 ft. above sea level at the head of Five Mile Rapids for any discharge less than 800,000 second feet with only moderate expense in the reconstruction of railroads, and this expense confined mostly to the O-W. R. & N. Co. Fig. 5 (see p. 376) shows a profile of both railroads and the amount of reconstruction necessary to permit control to the elevation mentioned. The indicated reconstruction of the S. P. & S. Railroad is principally downstream from the damsite and is made necessary in order to keep their grade above the elevation of the power canal from the damsite to the powerhouse site and to then drop down to the present roadbed of the railroad without exceeding their limiting grade of 0.2 per cent.

With this assumed constant level of headwater the operating head will necessarily fluctuate with changes in discharge according to the variation in tailwater level, which is not subject to control. The studies discussed in detail in Appendix "D" indicate that a gross head of 105.5 ft. or net head (after deducting the drop in canal) of 105 ft., would be available at the assumed minimum flow of 50,000 second feet and a gross head of 46.5 ft. or net head of 45 ft. at a discharge of 800,000 second feet.

Operation through this wide range to be practicable and efficient requires special treatment in the choice of machinery by the use of one set of units for the higher range of heads and another set for the lower range. This matter is fully discussed in Appendix "E."

Perennial power: The assumed minimum flow of 50,000 sec. ft. used under a head of 105 ft. would furnish at the generator busbars 480,000 electrical horsepower or 360,000 kilowatts continuously for 24 hours per day. This power would be available throughout the year except during years of rare droughts and extreme floods and will be referred to as the "primary or perennial" capacity of the power site. This figure is subject to whatever error is introduced by inaccuracies in assumed machine efficiencies and stream flow measurements. The former cause could not well introduce an error of more than 1 or 2 per cent, and the possible error in discharge measurements at this stage of the stream, as discussed in Appendix "E," is probably not greater than 5 per cent. Such errors moreover would not defeat the delivery of the primary generating capacity of the power site but would merely shorten or extend the periods of deficiency, which in any event would last for only a few days and recur only at rare intervals of several years.

Seasonal power: The maintenance of the primary power during high water requires the installation of a large amount of generating machinery which is not needed for primary power during low water, and which furthermore could not be operated then because of lack of water.

Between the minimum stage and the limiting flood there is always a surplus amount of water and also of machinery not in service for the production of the primary load. It is entirely possible to operate this machinery during these intermediate stages up to the limit of the flow of the river on the one hand or the capacity of the machinery on the other hand, each of these conditions controlling in turn for different stages of the river. The power thus generated would be available only a part of the year and would need to be sold at a reduced price; in fact, the price would need to be reduced in greater proportion than the proportion of the year during which it would not be available in order to compensate a manufacturer for interest on his plant cost and overhead expense during the shutdowns.

As discussed in Appendix "E," the amount of surplus or seasonal power thus possible of development would be about 120,000 horsepower for 11 months per year, 100,000 additional for 10 months per year and yet another 100,000 horsepower for 8 months per year, a total in all of 800,000 horsepower including the primary power. The installed machinery would permit this capacity to be raised up to 1,080,000 horsepower, but the duration would be so short each year as to make any power above 800,000 of questionable value for manufacturing purposes. This surplus power would be available in two seasons, spring and fall, with two intervening periods of deficiency caused by low water in January and February, and high water in June.

The durations above given for surplus power are much less than their average available periods, as discussed in detail in appendix "E." This is because a manufacturer could not economically develop a market which he could supply only during the average year, as his equipment would need to be increased to consume the surplus during high years in order to offset deficient years and thus realize the average amount of power actually paid for, and his product would also need to be stored in like manner to supply his customers during years of low stream flow. Surplus power would thus be salable only if it could be depended upon except during extraordinary years, and it is with this fact in mind that the above mentioned durations have been selected.

It should be said that the use of the machinery for generating surplus power requires the low head units to operate for a considerable time per annum at a head far above that for which they would be speeded and also at a low gate opening. This might conduce to a very rapid depreciation of the turbine runners due to erosion as discussed in Appendix "E." The sale of the surplus power will therefore be conditioned upon provision in the amortization fund for frequent renewals of turbine runners.

Power for irrigation pumping: An irrigation load is a seasonal load extending in this territory from April 1st to October 31st and having a peak demand, during June and July, of about twice the demand at the beginning and end of the season, as shown by Fig. 6. It so happens that the irrigation season does not coincide with the season of available surplus power as mentioned in the previous paragraph. The peak demand, or nearly so, occurs during June, which is a month of deficient power due to the annual flood and consequent reduction in head and generating capacity of the machinery. To be sure, the river is capable of generating much surplus power during this period, in

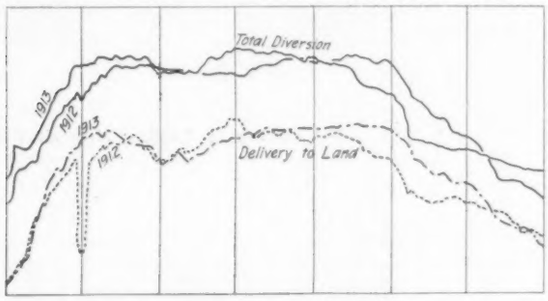


Fig. 6. Typical Irrigation Demand Curve (Sunnyside Canal, Washington).

fact enough to supply a peak irrigation demand of about 500,000 horsepower, but extra machinery to the full extent of this peak demand would be required to do so, and this equipment would be of little if any use during the remainder of the year. Moreover, space for extra equipment and canal width is difficult and expensive to secure. For these reasons this station is not adapted to supplying an irrigation load considered as a surplus load for which power might be sold at a low price; power for this purpose should be sold at only slightly below the price of primary power as its use is in lieu of the use of this amount of primary power for any other purpose.

Auxiliary power for present distribution systems: The fall period of surplus power at this station coincides closely with the period of minimum flow and power in nearly all generating stations thus far constructed in this territory, including the Willamette Valley in Oregon, the Puget Sound district of Washington as well as all of eastern Oregon and Washington. Several large distributing companies are operating in these districts and all are confronted by the necessity of providing water storage, steam auxiliary or more hydroelectric power plants, to maintain their load during the dry season. Surplus power from the proposed station, used to supply this deficiency at cheap cost, would add greatly to the ultimate economical generating capacity of most hydroelectric stations in this territory. Its use for this purpose would be in lieu of an equal use of surplus power for manufacturing purposes as it would so reduce the duration of surplus power for the remainder of the year as to make it of little value.

Summary of Power Available.

480,000 primary electrical horsepower available at generated voltage throughout the year for manufacturing, railroad or irrigation service;

120,000 surplus electrical horsepower available 11 months per year;

100,000 surplus electrical horsepower available 10 months per year;

100,000 surplus electrical horsepower available 8 months per year for manufacturing operations and as auxiliary for existing public service companies.

(To be continued.)

LOYALTY OF CORPORATION EMPLOYES.

BY R. H. BALLARD.

(The several factors of corporation welfare work whereby loyalty is instilled in the minds of the workers of the Southern California Edison Company, of which the author is secretary and assistant general manager, are here detailed. This address was given before the Los Angeles Section of the American Institute of Electrical Engineers, Oct. 21, 1915.—The Editor.)

Why are corporation employes the most loyal workers of the world?

Because down through the long line to the new recruits in the ranks, hope is the inspiration, fear does not exist to impair efficiency; the square deal is every man's due and woven in with every day's work is the purpose ahead. Each worker knows that the company is trying to help him achieve the highest purpose for which he is fitted and that his superiors are his friends, his co-laborers are his partners and that within the organization is his present and his future.

He is encouraged to achieve—not goaded on by carping to the constant rattle of the tin can. It is a practical day by day living out of the Three Guardsmen slogan—"One for all; All for one."

When a body of intelligent men get this one big-family thought ingrained through their systems they forget to be little. The employe with a big thought which embraces his boss and his work-mate and his work has neither time nor the disposition to knock. Real genuine down-in-the-heart loyalty is the great antidote to knocking.

Among the things that we try to do is to develop the human load-factor. The corporation represents the brains and the work of many men merged for one purpose. The man is the unit. The higher the potentiality of each unit, the higher the potentiality of the organization.

With our company a large number of our men have been with us since the organization was an infant. Their love for the company and their loyalty to it is something inspiring. It is like the comradeship of veterans of many campaigns. It is contagious. When new recruits join our ranks they get the spirit before they know it.

Fitness, mental and physical, is a necessary requirement for entry into an organization which has perpetuity as its object. An applicant for employment is required to pass a physical examination, after that our physicians look after his physical well being. Each employe pays a monthly nominal fee, but the chief burden, the expense of maintaining the department and hospital service, is borne by the company. Our chief surgeon and his assistants watch over the health of our men and women with the care and fidelity of family physicians and naturally this engenders many tender ties.

We have a benefit fund, which is in the nature of a mutual insurance. This had its inception with the employes themselves and for which the company stood sponsor until recently when by popular vote of the members the company was asked to take charge of the fund entirely. It has been in existence for five years and has paid losses totalling $21,699. The average payment has been $943 and the average monthly cost 40 cents. One of the finest features of

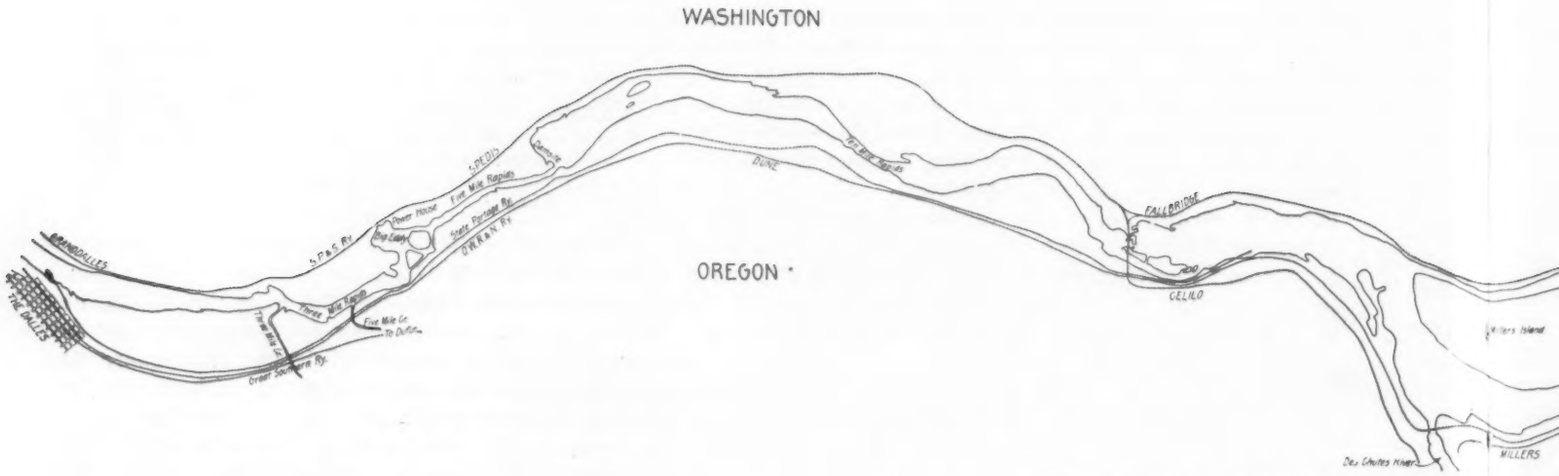


Fig. 1 Outline Map showing Portion of Columbia R

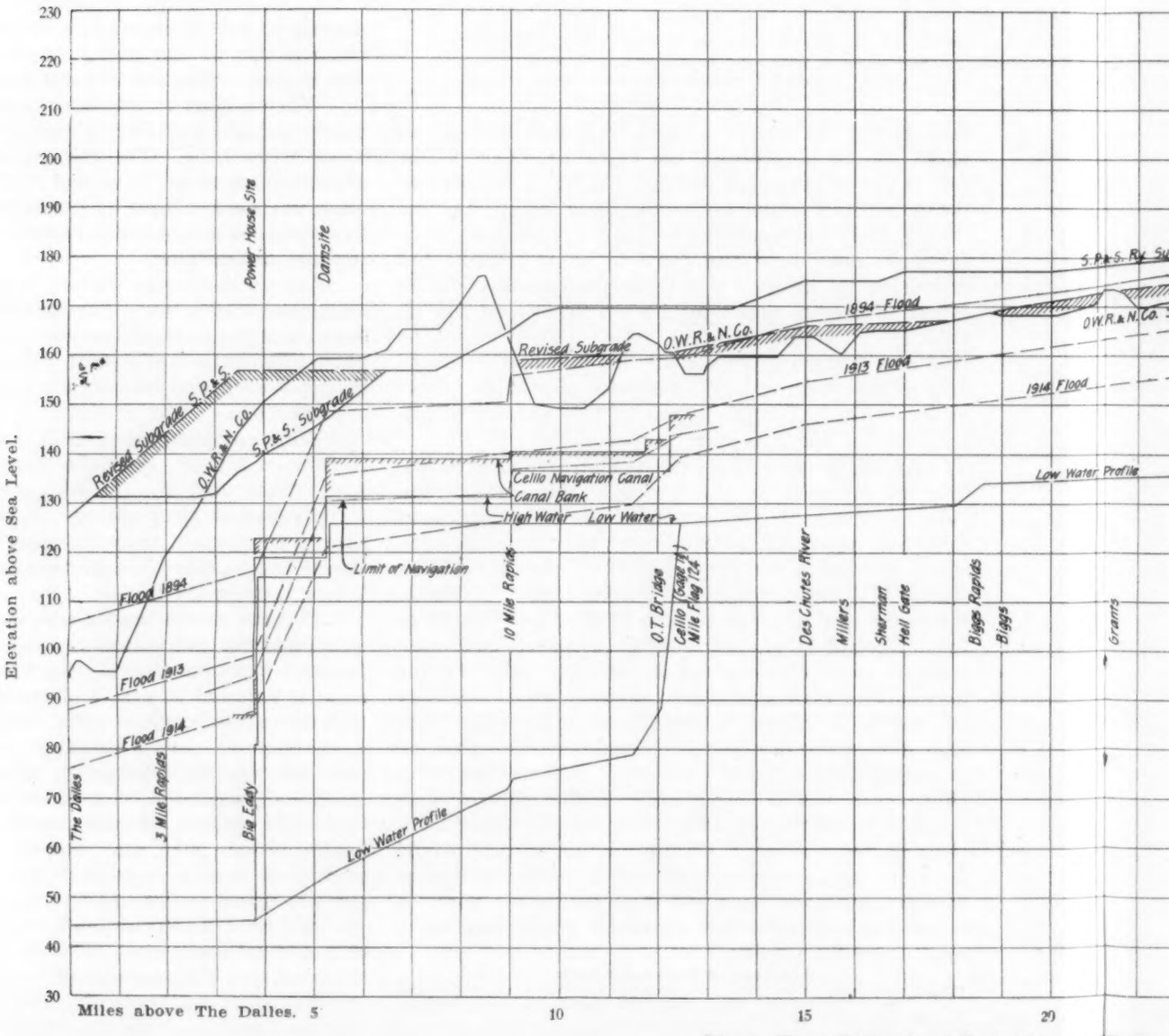
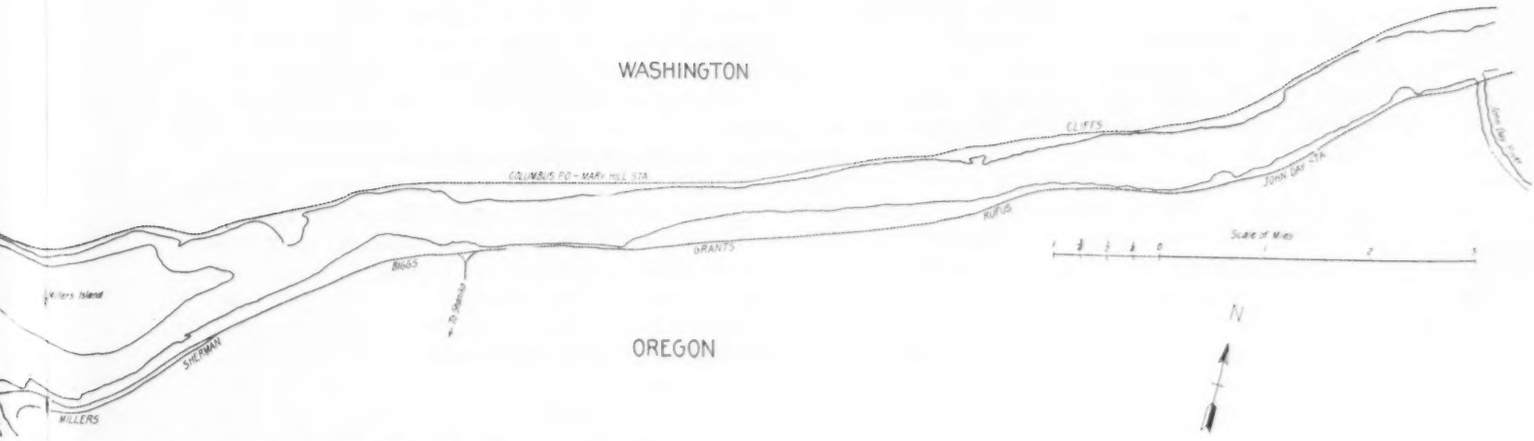
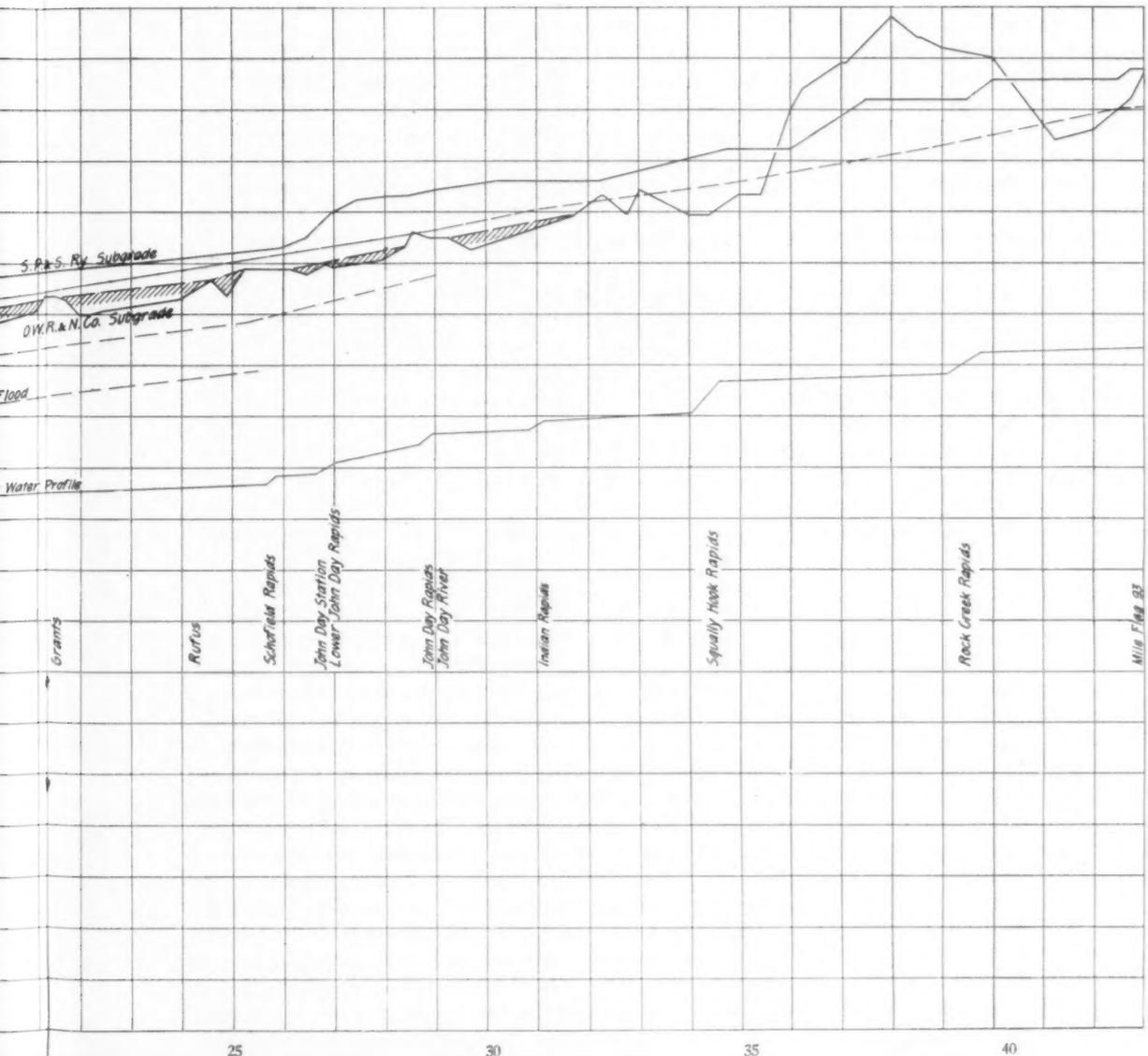


Fig. 5. River, Railroad and Navigation Canal Profiles



Columbia River Covered by Topographic Survey.



Canal Profiles, showing Proposed Railroad Revisions.

this co-operative insurance is that there is no delay in the payment; sometimes within an hour after a member has died the money has been paid to the family—not as a charity but as a right.

We have a safety committee, composed of the members of the engineering and operating departments, who systematically instruct our employes in means of bodily safety and endeavor to safe-guard them in all of their labors and walks of life.

Long and faithful service is encouraged, and employes who try to do their best are not harassed by a fear of losing their positions. If a failure is made or success not achieved in a particular line of work we try to find a place where the individual is better fitted. In a big organization there is usually an opportunity to fit the employe to the work for which he is best qualified. An insignia of service has been adopted in the form of an emblematic button. These conform to the number of years the employe has been in service. While this is literally a badge of honorable service, it symbolizes the bond of mutual interest which exists in the organization.

A circulating library is maintained by the company providing for employes technical and other instructive reading pertaining to business. Also subscriptions to the leading trade journals such as "The Electrical World" and "Journal of Electricity, Power and Gas" are either provided entirely to employes or the expense partly shared by the company. Weekly meetings of the commercial men are held locally for the purpose of education and business interchange. To further increase this educational feature, the company is about to assist materially all employes who are willing to take up the course in commercial engineering which has been recently organized by the National Electric Light Association.

What we term our district agents' meetings, but which are attended by officers, heads of departments, chief clerks and other employes who evince a desire to master the problems of the electric business, are held nearly every month. At these meetings the problems of the business are discussed; policies are formulated and pleasant personal relations are cemented. Many smaller meetings are also held.

To keep our employes in touch with the broader sphere of electrical achievement, which is national in character, we pay half of the expenses of all who join the National Electric Light Association. They receive all of its literature, which is inspiring and educational.

We publish a monthly house organ, known as "Edison Current Topics," which has for its object the education of the men who are not able to attend the agents' meetings and to keep them in constant touch with the officers and their co-employes and with the policies of the company. Its articles are almost entirely contributed by employes and treat business, technical and public questions from the standpoint of the practical man who is doing the real work.

Our employes are never asked to do anything dishonorable or contrary to clean business methods. It naturally follows that they respect their employers and respect themselves. The open door—the democratic policy, exists through the entire organization. There are no barriers which prevent an employe from talking freely and frankly with his superior on business or personal matters.

We always try to show appreciation of good work, and endeavor not to let an opportunity pass by to command enterprise, energy, efficiency and merit.

It is most gratifying to note the effect which these things have upon our men. We have come to take it practically for granted that every one is striving his best to give the company the best that is in him. While we are not lax in discipline or indulgent with those who persistently and wantonly disobey, it is astonishing how remarkably few instances arise where severe measures must be resorted to. The "call on the carpet" and "the bad half hour" are infrequent and "the third degree" is unknown. In the belief that we are all trying to do our best we try to realize that it is human to err. When a foot slips or a head goes dizzy there is most always someone who slips his arm through the arm of the delinquent one and whispers in his ear, "Old Pal, you're not doing right by the company, and that means that you're not doing right by yourself," and that usually suffices to steady the slipping foot and the dizzy head.

The problem of the business man of today, is to give personality to the great impersonal corporation which he directs. Such personality implies the human and it is only to be drawn from the human element in the organization. To reach this human element, you must forge a link of mutuality and co-operation between the employer and the employe. You have to arouse him to the plane of "sympathetic service," which means the success of both himself and the institution, and which is the influence that affects and determines his personality, the aggregate of which reflects itself in the personality of the business. To do this, you have to appeal to the man, the inner fibre of the man, which contemplates his material and mental welfare. He is to be taught to work not only with hand and head, but with heart, and he is to be afforded scope for his individual ambitions, hopes and expectations. The employer as represented in the corporation has to develop a conscience and the employe imbued with the possession of this conscience.

We try to make the feeling in our organization as close and loyal as that of a college fraternity. "Me and the president" is a term which most aptly expresses the feeling of relationship which should exist between the employe and the firm. If the employe considers himself a direct partner of the president, the man will work better and the president will fare better. The esprit de corps, or as it is affectionately termed in our organization, the Edison Spirit, is a real and tangible thing. It has been carefully nurtured from the first and is nothing new or visionary. It has a definite meaning to the employes in their relationship to each other and to the company.

Deeper and better than all the rest is that confidence which exists between us. It is manifest in the interest we take in each other. It is good when we can step between some one who is oppressed and the loan shark; it is better to see the president and the general manager go to the sick bed of some sufferer.

Yes gentlemen, corporation employes are the most loyal employes in the world.

Do you wonder at it?

EFFICIENCY OF ILLUMINATION.

BY RICHARD E. SMITH.

(The distinction is here clearly drawn between the efficiency of illuminants and of illumination, particular stress being laid upon the intangible element of satisfaction. The author is illuminating engineer with the Pacific Light & Power Company at Los Angeles.—The Editor.)

At this time when thousands of the gas-filled lamps are being sold simply on the statement that they are "more efficient" it seems appropriate to discuss the distinction between efficiency of illuminants and the efficiency of illumination. This paper has been suggested by the countless misapplications of the new lamp—installations that are hurting the reputation of this lamp which, in its proper place, certainly shows its merit.

In our industry various factors which ought to supplement each other frequently work at cross purposes. Thus we see lamp salesmen urging the use of lamps under circumstances that are found to result in dissatisfaction. On the other hand, some central station representatives discourage changes because they fear loss of revenue. Between the two we find the contractor who will encourage that installation that will net him the most money. There is a lack of balance. This can be avoided by an agreement between the various interests to encourage only those applications of new appliances which will really benefit the consumer and increase the prestige of the industry as a whole.

Efficiency means the greatest gain for the least outlay. In purely mechanical problems it resolves itself into simple arithmetic. In illumination, however, there is so much of the personal equation that the most lumens per watt or lumens per dollar is not the final issue. Personal satisfaction cannot be reduced to mathematics.

In the same way that illumination is most efficient which gives the highest degree of satisfaction. To determine the nature of this desired satisfaction requires a careful analysis of each individual case. Efficiency of illumination should be measured by the efficiency of the people affected by the illumination and not by foot-candles on the working plane.

In a railroad yard this may be obtained by using flame arcs which enable the men to get around among the cars to the best advantage. In a club it may be obtained from an indirect fixture which gives out a restful light and encourages relaxation. The flame arc is the more efficient illuminant but in each case we have the most efficient illumination.

Take another case. The most efficient illumination in the show windows of a jewelry store may be derived from gas-filled lamps in good reflectors. But for a display of fine silks such light would not be satisfactory. It is better to have the mellow rays from the vacuum lamps; in some cases color screens may be used. Here we are guided by the window trimmer's knowledge of shoppers rather than the engineer's knowledge of lamps.

To be sure, there are cases where economy is so important that other factors must be neglected. But the majority of consumers want the most satisfactory light obtainable rather than the least expensive. If this were not the case gas would be a more serious competitor.

Central stations of the new school are showing a tendency to give more and more real service to their consumers. Not only do they supply current but they show the best method for applying this current. This service can be vastly augmented by instructing employes in the rudiments of illumination and urging these representatives to pass this instruction along to the consumers whom they meet in many intimate ways. To most people these men are the corporation and the whole organization is judged by their knowledge and attitude.

We will be aided in such a campaign of education by the fact that the layman is better versed in the elements of electricity than he was ten years ago. Most intelligent consumers now understand volts and watts. They can read meters and estimate their bills. While they do not understand lumens and foot-candles, their minds readily grasp the significance of new terms.

The central station as a public servant should teach the principles of good lighting. Without resorting to technical language it is a simple matter to explain this efficiency of illumination to consumers. Let them understand how essential artificial light is to modern life. Show them that the electric bill is not a war tax to which they must subscribe whether they like it or not, but rather it is a small sum for which they get something that lengthens the day and gives additional hours for labor or recreation. Explain the harm of glare, flickering, shadows, over-lighting and under-lighting—in short, the essentials of good illumination.

Only in this way can we approach the desired Utopia—a host of saitsfied consumers. It has been demonstrated repeatedly that the customer will pay, cheerfully, for good service. The reward will be certain. Complaints will diminish and revenues will increase. And then there is that personal satisfaction in knowing that what we are doing is exactly right.

Cold light, as distinguished from the usual form of artificial lighting due to temperature radiation from solid particles, is produced by chemical reaction, usually oxidation. The fire-fly, for example, secretes a substance which oxidizes with a luminous cold flame, even after the animal is dead and the secretion has been preserved for years. Other chemical reactions are known to give light without heat, but none yet found are suitable for commercial purposes.

Sun valves, acting on the principle of the thermostat, are used to regulate the supply of acetylene gas employed for lighting five beacons connected with the Panama Canal. The presence or absence of sunlight turns on or shuts off the supply of gas to the burner, ignition being produced by a pilot flame. Tests have shown that these valves give a great saving in gas for the larger lights, and that they operate satisfactorily. Each valve costs $135, so they are installed only where the gas consumption is sufficient to justify the investment.

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Unlocking the Columbia Power Report

By a happy combination of circumstances it has become the privilege of this journal to publish what is believed to be the most exhaustive preliminary investigation yet made of an hydroelectric power project—the report on the Columbia River power development near The Dalles, Oregon. Here, "where the mighty Oregon once heard no sound save its own dashings," is the destined center of a great industrial development. Yet, because of political friction, lack of funds and the fact that the report is unfavorable, the results of this painstaking inquiry were to have been buried in the archives of the State of Oregon and the U. S. Reclamation Service, by whom the study was jointly conducted. So it is with pleasure that we are enabled to announce that the engineering world may now profit from these investigations. The first installment is published in this issue, and the entire report will appear in serial form during the next few months.

Nobel Laureates in Physics

Announcement of the award of the Nobel prize in physics to Edison and Tesla gives foreign confirmation of the high regard in which the work of these men has been held in America. This prize is annually awarded to those who "have conferred the greatest benefit on mankind." In 1896, Alfred Nobel, the inventor of dynamite, bequeathed his $9,000,000 fortune as a fund, the interest on which is divided into five parts to be allotted respectively to the person who shall have made the greatest discovery or invention in the domain of physics; chemistry, physiology or medicine, literature and peace.

In the earlier years of the foundation, from 1901 to 1906, the startling revelations as to the ultimate constitution of matter received first recognition. Rontgen's discovery of the x-ray, Becquerel's clue that radiations were produced by uranium, the discovery of radium by P. and Marie Curie, the announcement of the identity of the Rontgen and Becquerel ray by Thomson, were the foundation stones in the modern theory of matter, each of these individuals receiving the prize. Then Zeeman, who found the influence of a magnetic field in widening the spectrum of a gas, Lorentz, who conceived the idea that light had its origin in the movement of electric charges in the atom and who formulated much of the modern theory of electricity, Lord Rayleigh, who discovered argon and with Lenard disclosed the nature of electrons, were elected laureates.

In 1907, Michelson was the first American scientist to be honored. Though born in Prussia, he received his early education at San Francisco and graduated from the U. S. Naval Academy at Annapolis. He has made careful research into the wave length of light and expressed the length of the standard French meter in absolute terms of the length of a definite light wave. Lippman received the award in 1908 largely because of his inventions in the field of color photography based on the principle of light interference. In 1909 Marconi and Braun shared the honor on account of their work in radio telegraphy, Braun having made directive sending possible, and having also found a method of increasing the energy of the wave.

The first recognition of achievement in low temperature work was accorded to van der Waals in 1910, his investigations and equation of the continuity of the gaseous and liquid state being important guides in directing the liquefaction of most of the permanent gases. These studies culminated with the liquefaction of helium and a consequent low temperature record (—247 degrees F.) by Omnes, who was awarded the prize in 1913.

Wien, who received the honor in 1911, determined the mass of the positive electron, investigated the distribution of energy among the wave lengths of light, and has done much toward unifying the conceptions of light, electricity and matter.

The only native of Sweden to obtain the prize (1912) was Gustaf Dalen, whose invention of self-acting governors for use with acetylene gas lighting of buoys and light houses has contributed greatly to the safety of navigation.

The work of Edison is so well known as to require no explanation here. Tesla, likewise, has invented many improvements in dynamo-electric machinery—the polyphase current motor, the unipolar dynamo and the Tesla coil transformer.

In making these awards to date, it is evident that preference has been shown to the discoverer, rather than to the inventor. While some may question whether the practical inventions of wireless telegraphy, automatic gas lighting, the incandescent light and electrical apparatus have not the greater utilitarian value, there can be no doubt regarding the benefit to humanity from the recent disclosures as to the electrical nature of all matter, discoveries which have come perilously close to answering the "riddle of the Universe."

Unifying Diversity

Of the making of organizations there seems to be no end. The meetings of electrical men, alone, are so frequent as to form a serious distraction from business. Is it not time that all these "get together" associations get together themselves and put an end to the duplication of effort and this overlapping of endeavor which is now involved?

Electrical men foregather for three purposes—the interchange of technical knowledge, the promotion of their business and the encouragement of good fellowship. These three motives, the technical, the commercial and the social, are so distinct as to require specialized organization for their accomplishment. Three such national organizations now exist—the American Institute of Electrical Engineers, the National Electric Light Association and the Jovian Order. These three organizations already include, or can be made to include, all duties now performed by a host of weaker associations.

What is being accomplished by the Institute of Radio Engineers, the Illuminating Engineering Society or the American Electrochemical Society, which could not be accomplished by a wireless telegraph, a lighting or a chemical section of the American Institute of Electrical Engineers? Did not two of these organizations hold joint meetings with the Institute during the Panama-Pacific convention last September largely because they were not strong enough in the West to conduct separate meetings? Could not the Institute handle the technical papers now presented before the National Electric Light Association much more effectively?

On the other hand the National Electric Light Association is far better adapted for the intelligent discussion of some of the papers on rate-making, public policy and commercial subjects which are occasionally submitted to the Institute. It is most significant that the Electric Vehicle Association has recently expressed its willingness to affiliate with the National Electric Light Association. The Society for Electrical Development might well do likewise, especially since the Association has accorded fuller recognition to the manufacturers of electrical equipment. It is quite possible that the several associations of electrical manufacturers will find it to their advantage to merge with these larger organizations. The same suggestion applies to the jobbers' association, which is even now asking for the co-operation of the central stations in the education of the contractor. The contractors, similarly have much to gain from the Association. In fact every man in any way identified with the electrical business as distinguished from electrical science, is a logical prospect for membership in the National Electric Light Association.

The Jovians have demonstrated their ability to promote good-fellowship and sociability. By taking charge of the entertainment features of any meeting they can accomplish much good. By their weekly luncheons they create a better feeling among all electrical men. But as a commercial or technical association they are not so well fitted.

With three such strongly centralized national organizations having definite objects in view, the local members could be encouraged to form local sections to carry on the general work in each locality. In Portland, for example, members of the National Electric Light Association are co-operating with members of the American Institute of Electrical Engineers in conducting monthly evening meetings. Bi-weekly luncheons are also held, the active workers all being Jovians.

The electrical men of each community, whether engineers, salesmen or contractors, have enough in common to justify a strong localized club concerned with home matters. Membership in any one of the national organizations should be sufficient to entitle one to membership in the local organizations upon payment of nominal dues to carry on the local activities. Thus it would be possible for each individual member to think and act nationally as an engineer, a commercial man or a good fellow, and also think and act locally as a man interested in all three branches of the industry.

There is an increasing opposition to centralized organizations which do not accord sufficient recognition to the various geographical sections. There are too many sectionalized branches which have not the strength of a centralized body. Consequently the suggestion seems opportune that there be a general house-cleaning among the little organizations and an extension of activity on the part of the big societies. Consolidate the sections and localize the consolidation.

PERSONALS

E. H. Schmitz, electrical dealer of Woodland, Cal., was a recent visitor at San Francisco.

G. Arbogast, an electrical contractor of Los Angeles, was a recent visitor at San Francisco.

L. Demeree, of the Dinuba Electrical Works, recently spent a few days at San Francisco.

Gaylord A. Freeman, vice-president Walker Vehicle Company, of Chicago, is at San Francisco.

C. Schemmel, manager of the Gilroy Telephone Company, Gilroy, Cal., was a recent visitor at San Francisco.

A. Bradley, electrical engineer of the Hammond Lumber Company, Eureka, Cal., was a recent visitor at San Francisco.

P. M. Downing, of the Pacific Gas & Electric Company, San Francisco, returned the first of the week from New York.

J. O. Jensen of the Los Gatos Telephone Company, Los Gatos, Cal., spent a few days at San Francisco during the week.

C. D. Lamaree, of the Westinghouse Electric & Manufacturing Company, Los Angeles, Cal., was a visitor at San Francisco.

W. Hanisch, manager of the Roseville Telephone Company, Roseville, Cal., spent a few days at San Francisco recently.

H. L. Bleecker, vice-president Washington Water Power Company of Spokane, was at San Francisco during the past week.

R. E. Frickey, electrical engineer for the Northern California Power Company, Redding, Cal., was at San Francisco this week.

E. A. Quinn, general superintendent of the San Joaquin Light & Power Company, Fresno, was a recent visitor at San Francisco.

E. B. Goldsberry has succeeded **F. C. Fitzgerald,** resigned, as manager of the Hardin Electric Light & Power Company at Hardin, Mont.

Geo. F. Nevins, treasurer of the Pacific Power & Light Company, has recovered from an operation, and is in his office at Portland again.

A. J. Davidson has succeeded **E. E. Lillie,** transferred, as superintendent of the Spokane & Inland Empire Railroad and the Spokane Traction Company.

R. W. Brockett, chairman of the public policy committee of the N. W. Electric Light & Power Association, was at Portland last week from Seattle.

A. E. Wishon, assistant general manager San Joaquin Light & Power Company, Fresno, Cal., was a visitor at San Francisco the first of the week.

E. W. Newcomb, representative of the Thos. A. Edison Company, San Francisco, left the first of the week for a business trip to Portland and Seattle.

E. H. Dewey of Boise, Idaho, is now president of the Boise Valley Traction Company, which has acquired the properties of the Idaho Traction Company.

F. A. Richards of the Brill car department of Pierson, Roeding & Company, San Francisco, is on a trip east during which he will visit the Brill factories at Philadelphia.

C. Jensen, an electrical engineer of Drammens Electric Works, Norway, is a visitor at San Francisco. While in California he expects to visit the various hydroelectric plants.

F. Fagan, manager of the lamp department General Electric Company, San Francisco, returned the first of the week from a trip to Los Angeles in company with Thos. A. Edison.

Chas. Edw. B. Felch, engineer with the Richardson-Phenix Company, has returned to Milwaukee after installing a lubricating system in the Great Falls hydroelectric plant in Montana.

C. S. Walters, general manager of the Walla Walla Valley Railroad, and local manager of the Walla Walla office of the Pacific Power & Light Company, was a visitor in Portland, Ore., last week.

A. E. Rolinson, electrical engineer for the city of Redding, California, is a visitor at San Francisco. Mr. Rolinson has charge of the plans and specifications for the lighting of the city of Redding.

O. J. Fetch, formerly with the Portland Railway, Light & Power Company at Portland, is now connected with the commercial department of the Pacific Power & Light Company at Walla Walla, Wash.

C. H. Gaunt, Pacific Coast manager of the Western Union Telegraph Company, and party, have returned to San Francisco, after making a tour of the Pacific Northwest, so as to decide upon the telegraph requirement for the coming year.

W. D. Bee, vice-president of the Edison Storage Battery Company, Orange, N. J., returned the first of the week from a trip to Los Angeles and southern California and is spending a few days at San Francisco en route home.

H. W. Nimmo, electrical engineer of Burmah, India, is a visitor at San Francisco. While here it is his intention to visit the oil fields of California and the application of pumping motors to the oil industry with a view to their introduction in the oil fields of India.

Henry Floy, a consulting engineer of New York, is at San Francisco as representative of the Department of the Interior to investigate the application of the Yosemite Power Company for water rights on the Tuolumne River, which might interfere with the Hetch-Hetchy rights of San Francisco.

John H. Lewis, State Engineer of Oregon, attended a meeting of the American Society of Civil Engineers' committee appointed to consider the advisability of the enactment of a national water law at Chicago during the past week. **F. H. Newell,** ex-director of the United States Reclamation Service, now professor of civil engineering at the University of Illinois, is chairman of the committee. The other members are: **Charles W. Comstock,** Colorado, ex-state engineer; **Charles D. Marx,** of Leland Stanford University, and **Gardner S. Williams,** of Ann Arbor, Mich., president and vice-president respectively of the society; **W. C. Hoad,** professor of sanitary engineering at the University of Michigan; **Clemens Herschel,** of New York, and **Robert E. Horton,** of Albany, N. Y.

MEETING NOTICES.

Electrical Development and Jovian League.

The December 3rd meeting was presided over by Mr. W. H. Seaver as chairman of the day, the programme being interspersed with vocal and instrumental pieces rendered by Hawaiian singers. Mr. H. J. Knight was introduced as speaker of the day, relating in a most interesting way the growth and operations of the salmon-packing industry on the Pacific Coast. Some seventy-nine members were present.

Jovian Electrical League of Southern California.

A large number of Jovians and their friends attended the weekly luncheon of the league, held at Christopher's, Los Angeles, on November 3, presided over by Tribune Holland, and A. H. Van Konghoret acting as chairman of the day. After the customary introduction of guests and the imposition of fines, a number of Scotch songs were rendered by Miss Winifred Laird and Mr. Thomas Laird. An address on "The Application of the Rules of Business to the Science of Government" was then delivered by A. B. Cass, president of the Home Telephone Company. This will be printed in full in an early issue of this journal.

N. E. L. A. Section of Utah Power & Light Company.

The winter activities of the Utah Power & Light Company Section of the N. E. L. A. were inaugurated Thursday evening, October 28th, when officers for the ensuing year

were elected. Seventy-five employes, including practically all of the company's officials, were present and the unusual interest shown presages a most successful season's work. The following officers were elected: Chairman, C. E. Groesbeck, vice-president and general manager; vice-chairman, C. E. Green, manager Salt Lake division; secretary, Mr. Burton, legal department; treasurer, P. M. Parry, manager Ogden Division.

S. R. Inch, operating manager of the company, in a brief talk quoted statistics showing the rapid growth of the electrical industry, and pointed out that only through such an agency as the N. E. L. A. could the individual units in the industry keep pace with progress. The company section, he said, brings first hand information of the very latest developments to every employe at a minimum of effort and expense and at the same time fosters a spirit of co-operation which has had so much to do with the remarkable expansion of the electrical industry. Markam Cheever, chief engineer, also spoke of the many advantages of membership in the N. E. L. A. and also in the company section.

D. C. Green, who presided in the absence of Mr. Groesbeck, said that the best evidence of what the company's officers thought of the value of company section work could be found in the fact that they were willing to accept responsibility as officers in the section. He urged employes to enter into the work with the same spirit and assured them that benefits would accrue in direct proportion to the efforts put forth.

NEWS OF WASHINGTON PUBLIC SERVICE COMMISSION.

The commission has closed its set of offices in Seattle, and hereafter all work will be done at Olympia. The service bureau will be consolidated with the rate department under Rate Expert O. O. Calderhead.

NEWS OF IDAHO PUBLIC UTILITY COMMISSION.

The commission has granted permission to the Electric Investment Company, the Idaho Power & Light Company, the Southern Idaho Water Power Company and the Great Shoshone and Twin Falls Water Power Company to establish a schedule of rates for flour milling service based on a minimum of $30 per horsepower year on maximum annual demand.

The commission has granted a certificate of public convenience and necessity to A. V. Dunkle, permitting him to install an electric light and power plant at Kendrick. The cost of the system is estimated at $8000.

The commission has granted a certificate of convenience and necessity to G. H. Hodgin for the construction and operation of an electric light plant for Rockland.

NEW CATALOGUES.

Westinghouse Electric & Manufacturing Company are distributing an attractive leaflet on Electrical Gift Suggeslight fixtures for school.

"A Chain of Evidence" is the subject of Publication No. 14 from the Morse Chain Company, Ithaca, N. Y., illustrating and describing the Morse silent chain and showing a few of the many large power drives thus equipped.

"Holophane Refractors for Street Lighting" is the subject of a bulletin from the General Electric Company, which tells how this product of the Holophane laboratory has improved outdoor illumination with arc lamps or Mazda C series street lamps.

Bulletin No. 49,127, from Sprague Electric Works of the General Electric Company tells of "Ozonators for Use in Stores" in eliminating objectionable odors. No. 49,126 gives details of the application of Sprague ozonators to cold storage warehouses.

"Line Material and Rail Bonds for Mine and Industrial Haulage" is the subject of a comprehensive catalogue from the General Electric Company. It will facilitate a ready selection of material for building overhead trolley systems for mines and industrial plants.

The Edge Moor water tube boiler is the subject of a book published by the Edge Moor Iron Company, Edge Moor, Delaware, illustrating and describing the construction of the boiler, and showing tyical installations. Many valuable data are included regarding fuel, combustion, water and steam.

Six ampere pull switches are the subject of a 4-page folder, printed in two colors, which the Cutler-Hammer Manufacturing Company of Milwaukee has just had prepared for distribution. The switches described and illustrated are of the ceiling, pendent, and threaded cap types, the shells being interchangeable with C-H 660-watt sockets.

"The Next Big Improvement in Automobiles" is the title of a booklet from The Cutler-Hammer Manufacturing Company, of Milwaukee, describing the C-H magnetic gear shift. The explanation of how the gears are shifted by push-button control of electro-magnets is wonderfully simple and the advantages of so equipping an automobile are simply wonderful.

The Simplex Electric Heating Company have issued two interesting catalogues of their heating devices. They are distributing many thousands of the smaller catalogues in colors to the homes, while the larger, showing the complete Simplex nickel line, is designed for dealers, which will undoubtedly be the means of enabling them to carry a small stock, as the large size illustrations will serve almost the same purpose as actual sample to prospective buyers. This is only one of the many advertising features for Prosperity Week.

Westinghouse Lamp Company has issued a new booklet on home lighting entitled "Lighting that Makes the Home Attractive." The reading matter has been subordinated to illustrations and there is just enough text to explain the various views of the home which are shown. All of the pictures were taken especially for the book, and each one illustrates a very definite point in the illumination of homes.

"Catalog B-21," from Benjamin Electric Manufacturing Company, illustrates and describes the various illuminating and wiring devices manufactured by that company. This booklet is notable, not only on account of the variety of accessories listed, but also because of the convenience of grouping. A numerical index gives in compact form full details as to standard package quantities, weights and discount schedules. Valuable illuminating data are included in the text.

TRADE NOTES.

The Home Electric Company of Tacoma has been awarded the contract for $10,000 worth of electric lamps for the city lighting department.

H. E. Gleason & Company of Seattle, Wash., at $3462, were low bidders and were awarded the contract for electric tions, giving illustrations and prices.

General Electric Company and Edison Lamp Works have removed their Los Angeles offices to the twelfth floor of the Corporation building, 724 South Spring street.

The Pacific Electric Welder & Manufacturing Company, Arcade building, Seattle, is building a plant for the construction of electric welding machines at Kent, Wash.

The Seattle board of public works awarded the contract for a year's supply of incandescent lamps to the Pacific Lamp & Supply Company at a price approximating $80,000.

The Hurley Machine Company is offering electrical dealers three cash prizes, aggregating $225, for the best window displays featuring Thor electric washing machines during Electric Prosperity Week, November 29 to December 4. A display machine is furnished without charge until February 1, and the decision is arrived at from photographs of windows submitted before January 5, 1916.

NEWS NOTES

ILLUMINATION.

BUENA PARK, CAL.—It is expected that a new lighting system will be finished and put into operation at once.

EMMETT, IDAHO.—The Electric Investment Company, Boise, plans to rebuild its electric light and power lines in this city.

HEDGESVILLE, MONT.—A proposition for the installation of water and electric lighting systems in Hedgesville is being considered.

TOPPENISH, WASH.—The service wires of the Pacific Power & Light Company will be installed next week. The work was authorized by Manager G. I. Drennan.

LAS VEGAS, N. M.—At a meeting of the property owners on Bridge street and on the Plaza, plans were made by which the street and Plaza will be lighted by a cluster of four lamps on each of the numerous poles.

SEATTLE, WASH.—Bids were received by the board of directors of the Seattle School District No. 1 for furnishing and installing of electric light fixtures for the new Ballard High School according to plans of the school architect.

GREAT FALLS, MONT.—A contract for the installation of a lighting system in special improvement district No. 258 has been awarded to the Electric Supply Shop for $5670, and for furnishing posts to the Great Falls Iron Works, $2385.

POLSON, MONT.—J. H. Cline has been granted a permit by the Interior Department for the construction of a hydroelectric plant on Big Creek in the Kalispell land district. He will utilize this plant for the purpose of furnishing electricity for municipal purposes in the town of Polson.

WASHINGTON, D. C.—Sealed proposals will be received until 11 a. m., November 27, by the bureau of yards and docks, Navy Department, for constructing one reinforced power house, one reinforced concrete operating building, and one wooden double quarters for chief operators at naval station, Pearl Harbor.

CHOTEAU, MONT.—The city council is considering the installation of an ornamental street lighting system, and it is planned to install 100 watt lamps with reflectors on the corners in the residence district and ornamental lamp posts in the business district. Information in regard to this system can be obtained from the city clerk.

ESCONDIDO, CAL.—For acquisition of electric light and gas plant, to be owned and controlled by the municipality, the city trustees have called an election on November 15th to vote on the proposition of issuing $50,000 worth of bonds, $40,000 for electric light and $10,000 for gas utilities. Bonds are to bear interest at 5½ per cent.

BOULDER CREEK, CAL.—H. C. Stilwell of Oakland and San Francisco, has succeeded in combining the Brookdale and Ben Lomond water and light plants. John C. Hughes of Oakland, will head the new company. It is the intention of the company to make many improvements in both systems and will at once install a mill and ice plant at the Brookdale works. The flumes will be enlarged.

TUSTIN, CAL.—At a meeting of the chamber of commerce the committee on lights reported there would be lights placed on C street, between First and Second, corner C and Second, corner C and Third, corner C and Fifth, Sixth and C, Second and Pasadena avenue, Third and Pasadena avenue, end of Fourth street and Tustin avenue, First and Glen, Second and Glen, Main street at end of Williams and change one on Main, Lyon and Main.

PALOUSE, WASH.—At the council meeting the initial step was taken toward a municipally owned electric lighting system. City Attorney McCroskey and the members of the committee were authorized to look into the matter with a view to calling a special election for the purpose of authorizing a bond issue for the purchase of the present plant. Investigation is also being made as to the possibility of developing water power on Big Creek.

PASADENA, CAL.—Eight bids for the reconstruction of the ornamental lights on Fair Oaks avenue, between Dayton street and Chestnut street, have been submitted. The Keystone Iron Works of Los Angeles was the low bidder for the work, on a bid of $1988. Other bidders were: Southern California Electric Company, $2495; Woodill & Hulse Electric Company, $2383; W. A. McNally Company, $2396; Chas. C. Glass, $2656; F. O. Engstrum Company, $2564; F. E. Newbery Electric Company, $2457; M. A. Stampher Company, $2355. The bids were referred to Commissioner Allin.

SALT LAKE CITY, UTAH.—The city commission has created lighting improvement district No. 2, and the city engineer's office is now engaged in preparing an estimate of its cost which will be ready for advertisement in a few days. This special district comprises Main street from South Temple street to Fifth South, a distance of five blocks. The proposed system contemplates the installation of fourteen special standards to the block, seven on each side of the street, the distance between posts being approximately 100 feet. Each standard will be equipped with three 6.6 ampere inverted type luminous arc lamps. The posts are arranged to fit over the trolley pole, the bottom of the bracket carrying the lamps coming just above the point where the span wire attaches to the pole. It is the intention when this system is completed to require the removal of all other posts and poles from the curb, so that this special lighting system will be the means of substituting for the present trolley pole, unsightly at the best, a highly decorative standard and removing all other obstructions to the view. The height to the lamps will be 27 feet and as the width of the street is 132 feet between property lines, the squatty, narrow effect so usual where the lamps are mounted low will be avoided. The system was designed by W. d'A. Ryan, who was specially comsioned by the Main street property owners to produce a system second to none in the country. Mr. Ryan, working along the lines which have proven so successful at the P. P. I. E., recommended the system above described; he urged that not only the street surface but also the face of the buildings should be well illuminated and that any system which failed to accomplish this lost much of its effectiveness. His recommendations were adopted and the system will soon be an actuality.

TELEPHONE AND TELEGRAPH.

KINGMAN, ARIZ.—The Arizona, California & Nevada Telephone Company has ordered a new switchboard with a capacity of 100 lines, for immediate shipment to Oatman.

NORTH YAKIMA, WASH.—The lines, poles, franchises and other property of the Tampico Telephone Company, a cooperative organization which has operated a telephone system in the Tampico Valley for the last five years, will be sold under foreclosure proceedings.

RED BLUFF, CAL.—The U. S. Attorney General has handed down a tentative decision approving the sale to the Sacramento Valley Telephone Company, a subsidiary of the American Bell Company, of the properties of the Tehama Telephone Company and the Glenn Telephone Company and the Tehama County holdings of the Pacific Telephone & Telegraph Company. The sale of the companies to the Sacramento Valley company has been approved by the state railroad

commission, but the permission of the attorney general was necessary, as a result of a stipulation entered into in December, 1913, by the American Bell Company, and the Department of Justice. By this agreement the Bell company agreed that neither it nor any of its subsidiary companies would buy out a competing enterprise. The deviation from the terms of the stipulation was permitted because it was shown neither the Tehama company nor the Glenn company is in financial condition to compete with the New Sacramento Valley Company.

TRANSPORTATION.

LOS ANGELES, CAL.—The board of public utilities has ordered the Pacific Electric Railway to install a wigwag signal at Jefferson and Main streets.

BAKER CITY, ORE.—On request of J. L. Soule for a street car franchise it was decided that the matter must be placed to a vote of the people, at a special election.

SAN JOSE, CAL.—The San Jose Railroad was the only bidder for a franchise for a standard gauge single track electric railroad upon Alum Rock avenue, and its bid was accepted.

LOS ANGELES, CAL.—A franchise to install a double track street railway on San Pedro street and South Park avenue from Thirtieth street to Slauson avenue, has been granted by the city council to the City Railroad Company. In constructing the new line the company will install grooved girder rails.

MEDFORD, ORE.—Permission has been granted the Southern Oregon Traction Company to abandon their Siskiyou Heights extension and use the rails and wires on a line to be built down the Hillcrest road, tapping Highcroft, Laurelhurst and Queen Anne additions, and for building of a line down West Main st.

DALLAS, ORE.—Preparations are still going forward for the electrification of the Monmouth and Independence railroad, better known as the Joe Hitchcock road. The latest move on the part of the managers is furnishing to builders of cars the specifications for the rolling stock contemplated for use under the new order of things.

LOS ANGELES, CAL.—Application has been made by the Pacific Electric Railway Company to the city council for a franchise granting a right to construct and for 21 years to operate and maintain a single or double track electric railroad along Front street, O'Farrell street, Newport street, and Bay street, in San Pedro. Sealed bids for the franchise have been called for.

SACRAMENTO, CAL.—The Northern Electric soon is to make some marked changes in its schedules. In order that the changes will not conflict with the schedules of the Oakland & Antioch and Central California Traction lines, a schedule that will be satisfactory to all the roads is being prepared. The Northern Electric, Oakland & Antioch and the California Traction trains are so dispatched that they connect in Sacramento. This connection is to be maintained.

LOS ANGELES, CAL.—Following a conference between President Lane of the board of public utilities and Franklin D. Howell on the one hand and President Shoup of the Pacific Electric, General Manager McMillan, Assistant Chief Engineer Johnson and Frank Carr on the other, it was announced that the railway company will begin construction of its elevated back of the Pacific Electric Building to connect with the San Pedro street line. The new elevated will cost about $300,000 and will probably consist of four or more stub tracks with an additional siding on the Los Angeles street property of the Pacific Electric with a passageway over Los Angeles street to connect with the present building by way of the Sunset-Room.

TRANSMISSION.

PHOENIX, ARIZ.—L. H. Foster and corps of engineers are at work on the survey of the power line extension to the Golconda mine ond on to Chloride by way of the Golconda Extension. The line means the possible electrifying of all mines along the range. It is possible that power will be extended to Cerbat and other points in the Wallapai district and may be extended to White Hills.

SAN FRANCISCO, CAL.—The Pacific Gas & Electric Company is planning to spend a large sum of money in improvements next year. The principal item is the laying of a submarine cable across the Golden Gate at a cost of $273,000. Other additions and betterments include a new office building to cost $114,000; plant at Knights Landing to cost $13,000; purchase of right of way for tower line from Oakland to Warm Springs to cost $22,500 and the installation of meters on all the flat rate consumers in Sacramento at a cost of $24,000.

VANCOUVER, WASH.—The properties of the Washington-Oregon Power Company were sold at foreclosure sale on October 30th to H. N. Putnam of Portland for $1,500,000. The properties include the water system and street railways of this city, the local and interurban railway system at Centralia and Chehalis, the electric and water systems of Hillsboro and other cities in the Tualatin Valley, Oregon, electric transmission lines running from Kalama, Wash., northerly to Tenino, and southerly to Woodland; with electric distributing systems in the towns of Bucoda, Tenino, Chehalis, Kelso and Kalama, Wash., and Rainier, Ore. The company also wholesales power to certain other public service concerns, and to the City of Centralia, Wash. It is expected that these properties will be transferred by Mr. Putnam to the North Coast Power Company, a Washington corporation recently organized, and that the latter company will operate them. The officers of the North Coast Power Company are as follows: Clarence M. Brown, president; H. L. Harries, vice-president; L. J. Morris, secretary and assistant treasurer; B. F. Donahue, assistant secretary and treasurer.

FRESNO, CAL.—The San Joaquin Light & Power Corporation is rushing along approximately $70,000 worth of construction work. This construction program is being carried out to accommodate a demand for electric power service only recently developed by fast-growing communities. At Merced Falls the coffer-dam and wheel pit have been completed and the foundation laid for the erection of a new plant. The machinery is expected to arrive about November 10th. This plant will cost about $35,000, while the dam, which was once used to control the water force for a power plant which was washed away several years ago, when the Exchequer dam broke on Merced River a few miles above, is valued at $75,000. The plant will be ready for operation by the first of the year. The power generated by this unit will be added to the general valley system, which embraces a 3000-mile transmission and distributing service. Riverdale now has plenty of electric service. The new line built through that section ties into the Carruthers substation. It is about 17½ miles in length and also gives service to Hardwick and Brown. The entire construction cost about $20,000. Plans for giving Cutler, Orange Cove, North Dinuba, Yettem, Raymond and Conejo electric service have been approved by the company management. In the section surrounding Orange Cove the company hopes to find an excellent market for power, as the ranches and farms are fast being developed. The cost of the service wires and general distributing system for the above sections will be approximately $12,000.

WATERWORKS.

PORTLAND, ORE.—The Suttle Lake Irrigation District in Jefferson county has voted bonds in the sum of $533,390 for the construction of an irrigation system for 35,000 acres to include a gravity system, with storage reservoirs at Suttles and Blue Lakes. O. Laurgaard, Railway Exchange Building, will have charge of the construction work and will probably call for bids at an early date.

ALPHABETICAL INDEX TO ADVERTISERS

The letter and number before each name are used in the classified page following

A-1 American Ever-Ready Works of National Carbon Co.... Los Angeles; 755 Folsom Street, San Francisco; Seattle.

Atchison, Topeka & Santa Fe Railway Co..... 4
673 Market St., San Francisco; 1218 Broadway, Oakland.

B-2 Benjamin Electric Manufacturing Co.....
590 Howard Street, San Francisco

B-5 Bridgeport Brass Co..... 4
(See Pierson, Roeding & Co.)

B 7 Busch-Sulzer Bros.-Diesel Engine Co..... 5
Rialto Bldg., San Francisco.

C-1 Century Electric Co..... 3
906 So. Hope Street, Los Angeles; 56 Natoma Street, San Francisco; 65 Front St., Portland, Ore.

C-3 Crocker-Wheeler Co.....
Salt Lake City; Crossley Bldg., 618 Mission St., San Francisco; Seattle.

C-4 Cutler-Hammer Manufacturing Co.....
579 Howard Street, San Francisco; Morgan Bldg., Portland, Ore.; San Fernando Bldg., Los Angeles.

D-1 D. & W. Fuse Co.....
Western Electric Co.

D-4 Davis Slate & Manufacturing Co.....
Chicago, Ill.

D-2 Dearborn Drug and Chemical Works..... 5
355 East Second Street, Los Angeles; 301 Front Street, San Francisco.

D-3 Dover Manufacturing Co.....
Canal Dover, Ohio.

E-1 Edison Lamp Works of General Electric Co.....
Rialto Bldg., San Francisco; 724 So. Spring Street, Los Angeles.

E-2 Edison Storage Battery Supply Co..... 4
441 Golden Gate Avenue, San Francisco.

E-3 Electric Agencies Co.....
247 Minna Street, San Francisco; Central Building, Los Angeles.

E-4 Electric Storage Battery Co.....
Pacific Electric Bldg., Los Angeles; Spalding Bldg., Portland; 118 New Montgomery Street, San Francisco; Colman Bldg., Seattle.

E-5 Electric, Railway & Manufacturers Supply Co.....
84 Second Street, San Francisco.

F-1 Fairbanks, Morse & Co..... 3
Los Angeles; Portland; 651 Mission Street, San Francisco; Seattle; Spokane.

F-3 Federal Sign System (Electric).....12
618 Mission Street, San Francisco.

G-1 General Electric Co.....10-11
724 So. Spring Street, Los Angeles; Worcester Bldg., Portland; Rialto Bldg., San Francisco; Colman Bldg., Seattle; Paulsen Bldg., Spokane.

G-2 General Vehicle Co.....
1117 Van Ness Avenue, San Francisco; 331 Wall Street, Los Angeles; British Columbia Electric Ry., Ltd., Vancouver, B. C.

H-1 Habirshaw Wire Co.....
(See Western Electric Company.)

H-2 Hemingray Glass Co..... 5
330 So. L. A. Street, Los Angeles; 345 Oak Street, Portland; 807 Mission Street, San Francisco.

H-5 Hunt, Mirk & Co..... 6
141 Second Street, San Francisco.

H-7 Hurley Machine Co..... 2
New York and Chicago.

I-1 Indiana Rubber and Insulated Wire Co.....
Fobes Supply Co., Portland and Seattle.

K-1 Kellogg Switchboard and Supply Co.....
Aronson Bldg., San Francisco.

K-2 M. W. Kellogg Co.....
(See Pierson, Roeding & Co.)

L-1 Leahy Manufacturing Co.....
Eighth and Alameda Street, Los Angeles.

L-2 Locke Insulator Manufacturing Co..... 4
(See Pierson, Roeding & Co.)

M-2 McGlauflin Manufacturing Co.....
Sunnyvale, Cal.

M-4 Morse Chain Co.....
Monadnock Bldg., San Francisco.

M-3 Moore & Co., Charles C..... 3
Van Nuys Bldg., Los Angeles; Spalding Bldg., Portland; Kearns Bldg., Salt Lake City; Sheldon Bldg., San Francisco; Mutual Life Bldg., Seattle; Santa Rita Hotel Bldg., Tucson.

N-1 Nason & Co., R. N.....
151 Potrero Avenue, San Francisco.

N-2 National Conduit & Cable Co., The.....
Trust and Savings Bldg., Los Angeels; Rialto Bldg., San Francisco.

N-3 National Lamp Works of G. E. Co.....
(All Jobbers.)

N-4 New York Insulated Wire Co.....
629 Howard Street, San Francisco.

N-5 Northwestern Pacific Railroad.....
808 Phelan Bldg., San Francisco.

O-1 Okonite Co. (The) 12
(All Jobbers.)

P-1 Pacific Electric Manufacturing Co.....
80 Tehama Street, San Francisco.

P-2 Pacific States Electric Co..... 2
236-240 So. L. A. Street, Los Angeles; 90 Seventh Street, Portland; 200-210 12th Street, Oakland; 575 Mission Street, San Francisco; 307 First Avenue, So., Seattle.

P-4 Pelton Water Wheel Co..... 5
2219 Harrison Street, San Francisco.

P-5 Pierson, Roeding & Co..... 4
Pacific Electric Bldg., Los Angeles; Rialto Bldg., San Francisco; Colman Bldg., Seattle.

P-7 Pittsburgh Piping & Equipment Co.....12
Monadnock Bldg., San Francisco.

S-1 Schaw-Batcher Company, Pipe Works, The.....
211 J Street, Sacramento; 356 Market Street, San Francisco.

S-3 Simplex Electric Heating Co.....12
612 Howard Street, San Francisco.

S-4 Southern Pacific Co..... 4
Flood Bldg., San Francisco.

S-5 Sprague Electric Works..... 3
Rialto Bldg, San Francisco; Colman Bldg.; Seattle; 124 West 4th Street, Los Angeles; Electric Bldg., Portland; Paulsen Bldg., Spokane.

S-6 Standard Underground Cable Co.....
First National Bank Bldg., San Francisco; Hibernian Bldg., Los Angeles; Yeon Bldg., Portland; Central Bldg., Seattle, Wash.

T-1 Thomas & Co., R.....
(See Western Electric Co.)

W-2 Western Electric Co.....
Eighth and Santee Streets, Los Angeles; 1901 Telegraph Avenue, Oakland, Cal.; 680 Folsom Street, San Francisco; 907 First Avenue, Seattle; 45 North Fifth Street, Portland, Ore.

W-4 Westinghouse Electric and Manufacturing Co..... 6
50-52 East Broadway, Butte; Van Nuys Bldg., Los Angeles; Couch Bldg., Portland; 212 So. W. Temple, Salt Lake City; 165 Second Street, San Francisco; Second and Cherry Streets, Seattle; Paulsen Bldg., Spokane.

W-5 Westinghouse Machine Co.....
141 Second Street, San Francisco.

W-6 Westinghouse Lamp Co.....
(See Westinghouse Electric and Manufacturing Co.)

W-8 Western Pipe & Steel Co.....
444 Market Street, San Francisco; 1758 North Broadway, Los Angeles.